APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

METHOD AND APPARATUS FOR SHARING A BLUETOOTH MODULE WITH TWO COMPUTING DEVICES

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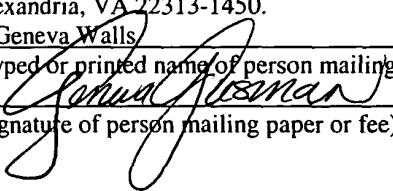60 S. Market St.; Suite 510
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METHOD AND APPARATUS FOR SHARING A BLUETOOTH MODULE
WITH TWO COMPUTING DEVICES

FIELD OF THE INVENTION

[001]   This invention relates to computer software and hardware, and more specifically to a

method and apparatus for sharing a Bluetooth host controller module with two computing

devices.

BACKGROUND OF THE INVENTION

[002]   As electronic and computer technology continues to evolve, communication of

information to a user at all times becomes increasingly important. For example, now more than

ever users of personal digital assistants (PDAs) are continuously checking email, looking-up

contacts, drafting documents on-the-go, and scheduling. Other users are utilizing mobile phones

with built-in PDAs. In addition to these new devices, more and more users are using tablet PCs

and notebook computers. The mobility of the powerful computing devices makes them ideal for

the business traveler. A general computing system for a mobile device will now be described.

A. Computing System

[003]   **Figure 1A** shows an embodiment of a mobile computing system 100. The

computing system includes a Central Processing Unit (CPU) 101, a cache 102, a memory

controller and bridge 103 and a system memory 104. Software instructions performed by the

computing system (and its corresponding data) are stored in the system memory 104 and cache

102 (where frequently used instructions and data are stored in cache 102). The software

instructions (together with corresponding data) are executed by the CPU 101. The memory

controller portion of the memory controller and bridge function 103 is responsible for managing

access to the system memory 104 (which may be used by functional elements other than the CPU

101such as the graphics controller 105 and various I/O units).

[004]   The graphics controller 105 and display 106 provide the computer generated images

observed by the user of the computing system 100. The bridge portion of the memory controller

and bridge function 103 provides a system bus 107 that multiple Input/Output (I/O) units 108_1

through 108_N may use to communicate with one another, the CPU 101, the system memory 104,

etc.. I/O buses109_1 through 109_N also interconnects I/O units 108_1 through 108_N to the system

bus 107. Here, I/O units are typically viewed as functional units that send/receive information

to/from the computing system (e.g., a networking adapter, a MODEM, a wireless interface, a

keyboard, a mouse, etc.) and/or function units used for storing information within the computing

system 100 (e.g., a hard disk drive unit). Note that the depiction of **Figure 1A** is exemplary and

other computing system architectures are possible (e.g., multiprocessor computing systems, for

example).

[005]   Buses 107 and 109_1 through 109_N may be bus structures, such as a Universal Serial

Bus (USB) bus, in order to couple a keyboard, mouse and other lower performance peripherals.

Also, "parallel" and/or "serial" ports (not shown in **Figure 1A** for simplicity) may also be

viewed as additional I/O units.

B. Bluetooth Wireless Network

[006]   **Figure 1B** illustrates a prior art wireless network 1000. Network 1000 includes a

mobile computing system 1100, such as described illustrated in **Figure 1A**. Computing system

1100 communicates with multiple Bluetooth enabled devices, such as mobile phone 1300,

personal digital assistant (PDA) 1200, or similar multifunction Bluetooth enabled device.

[007]   Mobile computing system 1100 communicates with Bluetooth devices 1200 and

1300 using Universal Serial Bus (USB) Bluetooth Adapter 1140, Personal Computer Memory

Card International Association (PCMCIA) Bluetooth card 1120, or an internal Bluetooth adapter.

[008] Bluetooth is a computing and telecommunications industry specification that describes how mobile phones, computers, and PDAs can easily interconnect with each other and with home and business phones and computers using a short-range wireless connection. Using this technology, users of cellular phones, pagers, and personal digital assistants such as the PalmPilot will be able to buy a three-in-one phone that can double as a portable phone at home or in the office, get quickly synchronized with information in a desktop or notebook computer, initiate the sending or receiving of a fax, initiate a print-out, and, in general, have all mobile and fixed computer devices be totally coordinated.

[009] Bluetooth requires that a low-cost transceiver chip be included in each device. The transceiver transmits and receives in a previously unused frequency band of 2.45 GHz that is available globally (with some variation of bandwidth in different countries). In addition to data, up to three voice channels are available. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters. Data can be exchanged at a rate of 1 megabit per second (up to 2 Mbps in the second generation of the technology). A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]   The accompanying drawings, which are included as part of the present specification, illustrate the presently preferred embodiment of the present invention and together with the general description given above and the detailed description of the preferred embodiment given below serve to explain and teach the principles of the present invention.

[0011]   **Figure 1A** illustrates an embodiment of a mobile computing system.

[0012]   **Figure 1B** illustrates a prior art wireless network.

[0013]   **Figure 2** illustrates an exemplary diagram of a Bluetooth network according to one embodiment of the present invention.

[0014]   **Figure 3** illustrates an exemplary diagram of a Bluetooth network, according to another embodiment of the present invention.

[0015]   **Figure 4** illustrates an exemplary multi processor computer system architecture, according to one embodiment of the present invention.

[0016]   **Figure 5** illustrates an exemplary multi-processor computer system architecture, according to another embodiment of the present invention.

[0017]   **Figure 6** illustrates an exemplary detailed diagram of a multiprocessor system for sharing a Bluetooth peripherals according to one embodiment of the present invention.

[0018]   **Figure 7** illustrates an exemplary detailed diagram of a multiprocessor system, for sharing a Bluetooth peripheral according to another embodiment of the present invention.

[0019]   **Figure 8** illustrates an exemplary flow diagram of a method performed for sharing a Bluetooth peripheral, according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0020] A method and apparatus for a Method And Apparatus For Sharing A Bluetooth Module With Two Computing Devices is disclosed. In one embodiment, a method comprises sharing a Bluetooth communicationsHost Controller module between a primary processor system and a secondary processor system.

[0021] In the following description, for purposes of explanation, specific nomenclature is set forth to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that these specific details are not required in order to practice the present invention.

[0022] Some portions of the detailed descriptions that follow are presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorithmic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

[0023] It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussion, it is appreciated that throughout the description, discussions utilizing terms such as "processing"

or "computing" or "calculating" or "determining" or "displaying" or the like, refer to the action

and processes of a computer system, or similar electronic computing device, that manipulates and

transforms data represented as physical (electronic) quantities within the computer system's

registers and memories into other data similarly represented as physical quantities within the

computer system memories or registers or other such information storage, transmission or display

devices.

[0024]   The present invention also relates to apparatus for performing the operations herein.

This apparatus may be specially constructed for the required purposes, or it may comprise a

general-purpose computer selectively activated or reconfigured by a computer program stored in

the computer. Such a computer program may be stored in a computer readable storage medium,

such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs,

and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs),

EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing

electronic instructions, and each coupled to a computer system bus.

[0025]   The algorithms and displays presented herein are not inherently related to any

particular computer or other apparatus. Various general-purpose systems may be used with

programs in accordance with the teachings herein, or it may prove convenient to construct more

specialized apparatus to perform the required method steps. The required structure for a variety

of these systems will appear from the description below.

[0026]   **Figure 2** illustrates an exemplary diagram of a Bluetooth network 200 according to

one embodiment of the present invention. Network 200 includes a computer system 230

connected to a host Bluetooth computing device 250 via USB cable 240. Computer system 230

is not Bluetooth enabled. Device 250 can be any multi-function Bluetooth enabled device such

as a mobile phone or PDA.

[0027] Computer 230 includes a Bluetooth sharing module 232 that allows the computer 230 to control the Bluetooth functionality of host device 250. In other words, the non-Bluetooth enabled computer 230 becomes a Bluetooth enabled computer 260 that communicates with Bluetooth devices 211-219. Sharing module 232 includes software drivers that allow both the processor in computer 230 and in the processor in host device 250 to control the Bluetooth functionality of host device 250. Although USB cable 240 is shown in **Figure 2**, the link can also be an RS-232 cable, firewire or similar high speed link. In another embodiment, sharing module 232 is included in host device 250. Additionally, sharing module 232 can stand alone with interfaces to both computer 230 and host device 250.

[0028] **Figure 3** illustrates an exemplary diagram of a Bluetooth network 300, according to another embodiment of the present invention. Bluetooth network 300 includes a multiprocessor computer 360 that communicates with Bluetooth devices 311-319. Multiprocessor computer 360 can operate in various states.

[0029] Computing system 360 has three primary states were useful tasks can be performed: 1) a high power, "normal on" state; 2) a "main CPU/OS based low power" state; and, 3) a "non main CPU/OS based low power" state.

[0030] The "normal on" state corresponds to a standard "normal on" state in which the computing system is operational and all of its primary architectural components are powered on. As a consequence, the computing system can be viewed as being within a "high power" state because its primary architectural components are consuming power.

[0031] The "main CPU/OS based low power" state corresponds to a state in which the main CPU is powered on and can execute software; yet, primary architectural components (notably, the graphics controller, the display, and various I/O units are powered down so that power consumption is reduced. Moreover, the main CPU itself, although functional, may be configured

so as to have reduced performance and reduced power consumption as compared to the normal

on state. In an embodiment, this is achieved at least by lowering the frequency of the main

CPU's clock speed as compared to the "normal on" state. As a consequence, the main CPU has

reduced processing speed, but, consumes less power.

[0032] The "non main CPU/OS based lower power" state corresponds to a state in which the

main CPU is powered down so that it cannot execute software based upon the computing

system's main OS. Note that the cache, the system memory, and at least the memory controller

portion of the memory controller and bridge unit may also be powered down (because they

largely support the main CPU's efforts to execute software).

[0033] In lower power state, wireless I/O is still powered on. Wireless I/O can use many

long and/or short range protocols. While long-range wireless standards may be available and

defined, the near proximity use of near and even co-located devices wants for the development of

a short-range wireless standard. One such short-range wireless standard that is in the process of

being embraced is preliminarily known by the name of "Bluetooth." Bluetooth, which is only one

example of a short-range wireless standard, is actually a combination of specialized computer

chips and software. Bluetooth is the name for a technology specification for small form factor,

low-cost, short-range radio links between mobile PDAs, PCs, mobile phones and other portable

devices which is published by the Bluetooth SIG Inc (see www.bluetooth.com) and standardized

by the IEEE as 802.15.1. Bluetooth, for example, also offers speedy transmission of up to one

megabyte per second, over 17 times as fast as a typical modem. One of the present Bluetooth

specification restrictions is to limit the transmission range so that the resulting radiation pattern

typically does not exceed 10 meters.

[0034] Additional short-range wireless standards include the IEEE 802.11 RF wireless

standards: 802.11 HR, 802.11b, and 802.11@5 GHz standards. Other exemplary short-range

wireless standards potentially useful with the present invention include: HiperLan, HiperLan II, HomeRF, SWAP, OpenAir, and other wireless protocols.

[0035]   **Figure 4** illustrates an exemplary multi processor computer system architecture 400, according to one embodiment of the present invention. Multi-processor system 400 includes main processing module 410 that includes USB host controller 414 and main CPU system 412. Main CPU subsystem 412 can include Pentium,™ Celleron™ or similar a multi-function IA32 microprocessors. Main CPU subsystem 412 can use the Windows™ operating system. Main processing module 410 is connected to sharing module 450 via USB link 430 according to one embodiment. Additionally, main processing module functions in high power state and main CPU/OS based low power state described above.

[0036]   Multi-processor system 400 also includes a secondary processing module 420 that includes a secondary controller 424 and low power CPU subsystem 422. Low power CPU Subsystem 422 can include Xscale™ or similar low power microprocessors. Low power CPU subsystem 422 can use the Windows CE™ operating system PALM™ operating system, or similar operating system. Secondary controller 424 is connected to sharing module 450 via a Universal Asynchronous Receiver/Transmitter (UART) interface 480, according to one embodiment. Additionally, subsystem 422 can operate in all three states above, but would only be a master of the Bluetooth module 460, while multi-processor system 400 is in a lower power state, as described above.

[0037]   Multi-processor system includes sharing module 450, as described above, that allows for main processing module 410 and secondary system 420 to share Bluetooth module 460. Sharing module translate packets in formats of main processing system 420 and secondary system 420, into modes used by Bluetooth module 460. Additionally, sharing module 470 presents Bluetooth module 460 as a peripheral slave device to both main system 410 and

secondary system 420. Sharing module 470 also functions as a switch to determine whether main system 410 or secondary system 420 should control the Bluetooth module 460 based on the overall power state of multiprocessor computer system 400. The switching decisions are made by sharing module 470 for numerous reasons. For example, the switch can occur when the notebook computer's lid is opened or closed; or if the computer receives a data message (e-mail, SMS, MMS, etc.). The switching is performed seamlessly.

[0038] Bluetooth module 460 includes a controller 464 and a Bluetooth subsystem 462. The Bluetooth module 460 is a stand Bluetooth radio module, such as those sold by Zeevo.

[0039] **Figure 5** illustrates an exemplary multiprocessor computer system architecture 500, according to another embodiment of the present invention. Main processor system 510 includes main CPU system 512 and USB host controller 514. Multiprocessor system 500 integrates sharing module 550 into secondary controller 524 of secondary processing system 520.

[0040] Bluetooth module 560 includes both a host controller 564 and subsystem 562. Secondary controller 524 interfaces with both Bluetooth module 560 and main processor system 510. The interface with main processor system 510 is USB 530 and the interface with Bluetooth module is UART 570. Secondary controller 524 can be active in all power states of multiprocessor system 500. While in high power state, and low power main CPU/OS on states, secondary controller acts as a slave and the main processor system 510 will control the Bluetooth module 560. Once, the lower power state is entered, low power subsystem 522 acts as a master, to control Bluetooth module 560.

[0041] **Figure 6** illustrates an exemplary detailed diagram of a multiprocessor system 600 for sharing a Bluetooth peripherals, according to one embodiment of the present invention. Main Processor system 610 includes USB host controller hardware 618, which communicates with secondary system's USB device controller hardware 627. Main system 610 also includes

standard USB host controller interface (UHCI) 617, USB driver (USBD) 616, and USB hub 615.

System 610 also includes a USB serial host protocol descriptor 613 (OSUSBSH) such as for

Windows CE™. Additionally, system 610 includes Bluetooth USB protocol definitions 614

specific to the operating system of main processor 610. The operating system can be Windows™,

Linux or similar system.

[0042]   Secondary controller 624 includes USB device controller hardware 627 to interface

with USB host controller 618, as well as UART controller hardware 626 to interface with

Bluetooth UART controller hardware 664. Secondary controller 624 provides a UART driver

625 and a sharing USB Function driver 650. The sharing driver 650 translates USB descriptors

to UART descriptors, as well as providing a USB driver, for use by hardware 627. Driver 650

extends USB descriptor configuration to support proprietary data communication applications.

Bluetooth UART Host Controller Interface 660 includes Bluetooth firmware 661, UART

firmware 662 and a UART hardware controller 664.

[0043]   The embodiment of **Figure 6** does not necessitate any changes to the main

processor's 610 operating system. Nor, is there a dependency on proprietary drivers, or effect on

application functionality run on main system 610. Higher layer Bluetooth components remain

unchanged as well.

[0044]   **Figure 7** illustrates an exemplary detailed diagram of a multiprocessor system 700,

for sharing a Bluetooth peripheral according to another embodiment of the present invention.

The functional components of system 700 are similar to those illustrated in **Figure 6**. However,

system 700 utilizes a second USB serial host protocol state with Bluetooth Serial descriptors 711.

Such a configuration allows for USB Function driver 750 in Secondary controller 724 to not

need to perform USB/UART translation, thus resulting in no packet based processing at

secondary controller 724.

[0045]   **Figure 8** illustrates an exemplary flow diagram 800 of a method performed for sharing a Bluetooth peripheral, according to one embodiment of the present invention. The process commences at block 801. At processing block 805, the sharing module routes communications between a primary processor system and a Bluetooth communication module.

At processing block 810, the sharing module routes communications between a secondary processor system and the Bluetooth module.

[0047] The communications packets are processed to properly translate transport protocols between USB and UART; at processing block 815, if necessary. At processing block 820, the Bluetooth module is presented to the main processing system as a USB peripheral device. The sharing module also selects and switches control of the Bluetooth module between the main processor system and secondary system based on the overall power state of the multiprocessor computer system.

[0048]   A method and apparatus for sharing a Bluetooth module with two computing devices is disclosed. Although the present invention has been described with respect to specific examples and subsystems, it will be apparent to those of ordinary skill in the art that the invention is not limited to these specific examples or subsystems but extends to other embodiments as well. The present invention includes all of these other embodiments as specified in the claims that follow.